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FIELD TRIAL OF TWO *BACILLUS THURINGIENSIS* VAR. *ISRAELENSIS* FORMULATIONS FOR CONTROL OF *AEDES* SPECIES MOSQUITOES IN MICHIGAN WOODLANDS

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ABSTRACT. Vectobac® and Bactimos® corn cob granules were evaluated for control of *Aedes* species mosquito larvae in woodland pools. No significant differences were seen between the 2 formulations. Both provided greater than 90% control at application rates as low as 100 mg/m² (0.89 lb/acre) and greater than 98% control at label-specified field application rates (2.5 or 5 lb/acre).

Woodland pool mosquitoes, primarily *Aedes canadensis* (Theobald) and species in the Stimulans and Communis groups, are extremely important in Michigan. These mosquitoes, commonly referred to as spring *Aedes* species, are bothersome in virtually all wooded areas in the state (Wagner and Newson 1975). Spring *Aedes* are potential vectors of Jamestown Canyon encephalitis virus, which infects up to 43% of Michigan residents (Grimstad et al. 1986) and dog heartworm. Mosquito control districts in Michigan currently treat more than 24,000 hectares of flooded woodland annually to control spring *Aedes* larvae.

Since its discovery in 1976 (Goldberg and Margalit 1977), *Bacillus thuringiensis* Berliner var. *israelensis* de Barjac (*B.t.i.*) has been shown to be an effective biocontrol agent for *Aedes* larvae (Ramoska et al. 1982, Knepper and Walker 1989). Michigan mosquito control agencies use *B.t.i.* almost exclusively to treat woodland pools for the control of spring *Aedes* larvae. Since 1984 the primary materials used by the Midland County mosquito control program have been either of 2 corn cob granule formulations, Bactimos Granules® and Vectobac-G®. Treatment results have varied somewhat over this time period (T. R. Wilmot, unpublished data) and it was not known to what extent observed variation related to material used. In large-scale field applications it is difficult to separate the effects of application efficiency, climatic factors and other variables from that of possible differences in efficacy.

The purpose of this study was to compare the effectiveness of Bactimos corn cob granules (5–8 mesh, 300 IU *Aedes aegypti*/mg) and Vectobac-G corn cob granules (5–8 mesh, 200 ITU/mg) against woodland pool mosquito larvae in controlled field trials.

The experiment was conducted in an 11.5-ha woodland in Section 33 of Larkin Township, Midland County, MI. This woodland contained a mixture of oak, maple, birch and pine. Pretreatment sampling was conducted on April 27, 1992. Applications were made the following day and pools were sampled again at 24 and 48 h posttreatment. Air temperature ranged from 2 to 15°C and there was no precipitation during this study, so pools remained at approximately the same size throughout. At this time, most mosquito larvae were in the 2nd or 3rd instar. Mosquito species present were *Ae. canadensis, Aedes provocans* (Walker) and *Aedes stimulans* (Walker).

During the pretreatment survey, 44 individual pools were selected on the basis of possessing distinct, fairly regular boundaries (to facilitate calculations of surface area) and of having the greatest numbers of mosquito larvae. Five pools were assigned at random to each of 8 treatment regimes (2 materials × 4 application rates). Four pools were left untreated as controls. Label-directed application rates for Bactimos and Vectobac granules in woodland pools are 4.48–8.41 kg/ha (4–7.5 lb/acre) and 2.24–11.2 kg/ha (2–10 lb/acre), respectively. Application rates used in this test ranged from 100 mg/m² (0.9 lb/acre) to 560 mg/m² (5.0 lb/acre). The surface area of each pool was measured, after which the amount of *B.t.i.* necessary to treat the pool at the assigned application rate was weighed and the granules distributed evenly by hand over the pool. Material used was from standard lots offered for sale during 1992, not specifically formulated for this experiment.

Samples consisted of 5 to 10 dips per pool with a standard 350-ml mosquito dipper. Percent reduction in number of larvae per dip from pretreatment to 48-h posttreatment samples was calculated for each pool. There was no significant difference from pretreatment to 48-h posttreatment in the number of larvae per dip in control pools (paired t-test, $P > 0.05$) so no adjustments were made for control mortality. Arcsine-transformed data were used for statistical analysis.

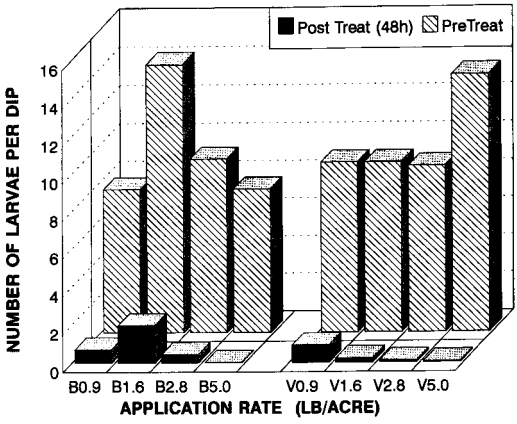

Fig. 1. Number of spring *Aedes* mosquito larvae per dip (mean of 5 pools per treatment) in pools treated with different rates of Bactimos® (B) or Vectobac® (V) corn cob granules.

The effects of formulation and application rate on percent control were evaluated with ANOVA (Sokal and Rohlf 1973).

No significant differences were seen between the 2 formulations ($F_{1,32} = 1.55$, $P > 0.05$). Although there was a significant effect of dose on percent control ($F_{3,32} = 5.16$, $P < 0.01$), both materials provided greater than 90% control at the lowest application rate used and greater than 98% control at field application rates (Fig. 1).

Larvicidal activity of *B.t.i.* in the field is influenced by a number of factors other than formulation and susceptibility of target species (Lacey 1985). A particular concern for spring applications is that the effectiveness of *B.t.i.* decreases with temperature. Temperatures below 4°C reduce larval feeding activity and the efficacy of *B.t.i.* against *Ae. stimulans* (Wraight et al. 1981, Walker 1993). This trial was designed to reduce the effects of other factors as much as possible and to estimate the maximum field efficacy of Vectobac and Bactimos granules for woodland pool mosquitoes. Granules were distributed evenly by hand over the entire surface of each pool. Applications were made before any larvae reached late 4th instar and during a time when average daily temperatures were above 7°C and no rain was predicted.

In large-scale programs, application efficiency will be reduced and other factors may affect treatment effectiveness, but the results of this study suggest that Bactimos Granules and Vectobac-G applied at label rates can provide equally excellent control of woodland pool mosquito larvae.

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